Summary for Intellectual Capital and Knowledge Systems

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Contents

1 Meeting 2: Human capital theory

1.1 (Becker, 1962) ”Investment in Human Capital: A Theoretical Analysis”

1.1.1 Stylized Facts

1. Earnings typically increase with age at a decreasing rate. Both the rate of increase and the rate of retardation tend to be positively related the level of skill.

   UU is the untrained person, TT trained person (first paying for, then collecting

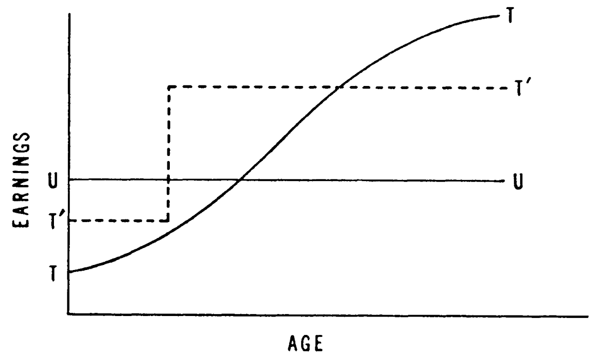

Figure 1: from Becker, p.15

   rent from training). Difference between UU and TT greater the greater the cost of and return from training. Not only does training make the curve steeper, but also more concave. Extreme case TT’.

2. Unemployment rates tend to be negatively related to the level of skill

   - market demand, $MP\dots$

3. Firms in underdeveloped countries appear to be more ”paternalistic” toward employees than those in developed countries

   - investment in activities outside the job are done when an increase in productivity is the result
   - e.g. health, anti-alcoholism
   - thus, this ”paternalistic” behavior results from typical behavior outside the firm!

4. Younger persons change jobs more frequently and receive more on-the-job training than older persons

   - decisions regarding human capital are NPV decisions
   - therefore, they are driven by the time-frame of the decision (on-the-job training)

5. The distribution of earnings is positively skewed, especially among professional and other skilled workers

6. Abler persons receive more education and other kinds of training than others
   - higher MP...

7. The division of labour is limited by the extent of the market
   - a larger market generates *incentives* for more specialization, as higher investments in education are rewarded by higher wages
   - thus, a "larger market" implies more demand for specialized skills...

8. the typical investor in human capital is more impetuous and thus more likely to err than is the typical investor in tangible capital

1.1.2 Basic Model

$$MP = w \tag{1}$$

Workers have different unique productivities (wages) in each period.

$$MP_t = w_t \tag{2}$$

Training lowers current receipts (R) and raises current expenditures (E). However this trend is reversed for future periods. Therefore: NPV consideration.

$$\sum_{t=0}^{n-1} \frac{R_t}{(1+i)^{t+1}} = \sum_{t=0}^{n-1} \frac{E_t}{(1+i)^{t+1}} \tag{3}$$

Now we only have training in the first period; Expenditures in first period are wages + cost of training (k); afterwards only wage. Receipts in all periods is MP.

$$MP_0 + \sum_{t=0}^{n-1} \frac{MP_t}{(1+i)^t} = W_0 + k + \sum_{t=0}^{n-1} \frac{W_t}{(1+i)^t} \tag{4}$$

We define term G

$$G = \sum_{t=1}^{n-1} \frac{MP_t - W_t}{(1+i)^t} \tag{5}$$

Now equation (4) becomes

$$MP_0 + G = W_0 + k \tag{6}$$

Now we need to include the fact that training takes away time from production. (MP'_0 what could have been produced, $MP_=$ what was actually produced, C is the sum of opportunity cost and the outlays on training) Equation (6) becomes

$$MP'_0 + G = W_0 + C \tag{7}$$

We see that G is the excess of future receipts over future outlays (a notion of return on training). Optimality condition: $G = C$ (return equals cost)

1.1.3 General Training

General Training: This kind of training generally increases the MP of the worker. Since the worker can switch jobs, he will have to bear the costs of this kind of training.

Hence, MP and W are raised by the same amount! $MP_t = W_t \forall t$

$$G = \sum_{t=1}^{n-1} \frac{MP_t - W_t}{(1+i)^t} = 0 \tag{8}$$

Thus, eq. (7) becomes

$$MP'_0 = W_0 + C \tag{9}$$
$$\rightarrow W_0 = MP'_0 - C \tag{10}$$

1.1.4 Specific Training

Specific Training: This kind of training only increases the MP of the worker for the specific firm. Consequently, in this extreme case firms are willing to pay for the training, since the investment is offset by increases in profit due to higher MP of the workers. On the other hand, workers will not be willing to invest, since they have "no gain" from this kind of investment. The gain is fully absorbed by the firm!

1.2 (Ben-Porath, 1967) "The Production of Human Capital and the Life Cycle of Earnings"

1.2.1 Assumptions

1. Individual utility is not a function of activities involving time as an input.
2. There is a fixed amount of time to be allocated every period to activities that produce earnings and additions to the stock of human capital.
3. The stock of human capital, K, of which every individual has some initial endowment, is homogeneous and subject to an exogenously given rate of deterioration, δ.
4. The stock of human capital is not an argument in the individual's utility function.
5. Unlimited borrowing and lending take place at a constant rate of interest, r.

1.2.2 Two stages of decision-making

a) The individual allocates the given periods of time between earning and producing human capital and finds the corresponding outlays on investment that maximize the discounted value of any time t of disposable earnings from t to T, where T is assumed with certainty to be the end of life.

b) Given the optimal time path of disposable earnings, the individual decides on the timing of the consumption.

1.2.3 The Model

a_0 wage, or "rental of human capital"

K a unit of human capital

Y_T earning capacity at time t

$$Y_t = \alpha_0 K_t \tag{1}$$

E_t disposable earnings in period t

I_T cost of investment, equal to $(Y_t - E_t)$

$$\begin{gathered} Q_t = \beta_0 (s_t K_t)^{\beta_1} D_t^{\beta_2}, \\ \text{where } \beta_1, \beta_2 > 0 \text{ and } \beta_1 + \beta_2 < 1 \end{gathered} \tag{2}$$

Q flow of human capital produced

D quantity of purchased inputs

P_d price of purchased inputs

s_t fraction of available stock of human capital allocated to the production of human capital

The fraction s_t is constrained by the condition

$$0_t \leq 1 \tag{3}$$

The rate of change of the capital stock:

$$\dot{K}_t = Q_t - \delta K_t \tag{4}$$

δ rate by which the stock of human capital deteriorates

1.2.4 Findings

- People make most of their investments in themselves when they are young, and to a large extend by foregoing current earnings.
- The larger the stock of human capital, the larger the earnings per unit of time that the individual could get in the market and therefore the higher the foregone earnings from diverting a unit of time away from the market.
- If $\gamma_1 = \gamma_2$ (Cobb-Douglas: Equation (17), p. 360) the more highly educated person is also better equipped for learning, so that his higher opportunity cost is matched by the greater amount of skills that he can acquire per hour.

- If $\gamma_2 > \gamma_1$ capital accumulation reduces the cost of producing human capital, and it is possible even in phase (ii) to have a stretch of time over which investment rises.
- Three phases will exist:
  - Available stock of human capital K_t is not large enough to satisfy demand.
  - Available stock is enough to supply the services demanded, so that $0 < s < 1$ and the services of human capital are truly a variable factor.
  - Stock of capital is too big so that the optimal policy requires more disinvestment than is feasible through deterioration, that is to produce negative quantities of human capital.
- *Normal case*: Capital stock does rise over a period, eventually as gross additions become very small and the stock becomes large this must be reversed, and toward end of life, T, the stock will decline, if there is any deterioration.
- $\dot{I}$ is always negative. Thus the curve of observed earnings exaggerates the rate of increase of earning capacity when the latter increases and understates its decline when it declines.
- If depreciation is zero, there is always, except at point T, an increase in the three types of earnings (E_t - disposable earnings, Y_t - earning capacity, $\hat{E}$ - observed earnings), and at each point in time their rank by rate of change will be the reverse of their rank by level.
- If there is no deterioration ($\delta = 0$) the ever rising curve of observed earnings is always concave from below.
- Possibility that optimal decision requires initial assignment of $s = 1$, or 100% of the labour force educating themselves.

1.3 (Lazear, 2003) "Firm-Specific Human Capital: A Skill-Weights Approach"

1.3.1 Fact sheet

1. The "skill-weights" view allows skills to be general instead of firm-specific. Instead the relative importance of skills makes them more or less attractive to employers.
2. $y_i = \lambda_i A + (1 - \lambda_i)B$ is the potential earning for a worker with skill set (A, B) at firm i.
3. λ_i reflects that firm i may weigh the two skills differently.
4. p is the probability that the worker is going to stay with the current company in the next period.
5. The difference between the earnings growth associated with a given amount of experience for those who stay and those who go leads on the *tenure coefficient.* The amount of wage growth the leavers get loads on the experience coefficient.

6. The worker must chose his investment strategy not knowing whether he will leave the firm or not. p is usually large enough so that he caters to the needs of the first job. When he looses his job he will also loose some income since his skill set will most likely be poorly matched to the new job.
7. The lower p, the less he looses through being let off.
8. The tenure coefficient should be negatively related to the amount of turnover in the occupation.
9. Those who leave a firm with unusual weighting patterns suffer larger wage loss for a given p.
10. $Marketthickness$ is modeled as allowing more search: Two draws occur, for the second of which the worker can decide whether to switch jobs or not.
11. In thicker markets a worker looses less on a move despite a more idiosyncratic investment strategy.
12. Investment increases over time because except for a perfect match between the preferences of the first and second company another round of investment is appropriate.
13. It is possible to generate tenure coefficients that are nearly the same size as the experience coefficients (90%).
14. The higher p, the large the tenure coefficient.
15. When λ takes extreme values it tends to be far away from $\bar{\lambda}$, which is why the uniform distribution yields lower tenure coefficients than the bimodal.

1.3.2 Findings

The tenure effects found in the empirical literature do not fit examples of firm-specific human capital well. The proposed approach of weighted general human capital provides the same implications but is more realistic.

- Like the traditional view, the skill-weights approach implies that workers who experience an exogenous change in job lose some earnings associated with their previous tenure
  - Loss grows as workers are with firm for longer.
  - Loss tends to be greatest when employment most secure.
  - The more idiosyncratic the firm's technology the larger is the loss.
  - Workers hedge against this loss by adopting a more external- oriented investment strategy.
- Size of the tenure coefficient varies with the thickness of the market.
- A firm may bear some or even most of the cost of skills that look general.
- Workers who are displaced from large firms will have greater earnings losses than those who leave small firms.

2 Meeting 4: Informal Learning

2.1 (Destré et al., 2006) ”Learning form experience or learning from others?”

2.1.1 Introduction

- Mincerian earnings function: Linear in education, quadratic in labor market experience.
- extended version: includes a quadratic function of tenure in the incumbent firm

Here, the authors have a dataset based in France, of 150,000 wage earners and 16,000 establishments. They furthermore distinguish informal training by means of learning from own experience and learning from others.

Figure 1: Schedules of marginal rates of return to tenure for three earnings functions

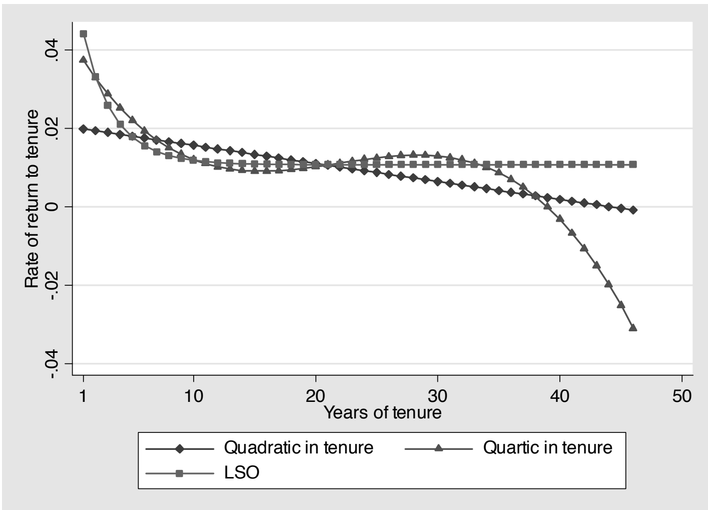

Figure 2: Destré, p. 30

2.1.2 Informal learning on-the-job from self and others: theory

- workers acquire job-specific training, either formally or informally. Both forms are costly, but the difference is that purely informal learning does not take time away from others.
- informal training often depends on the work contract. workers are ”forced” to acquire the knowledge of the firm. Thus, workers bear the cost of training, but also reap the rewards.

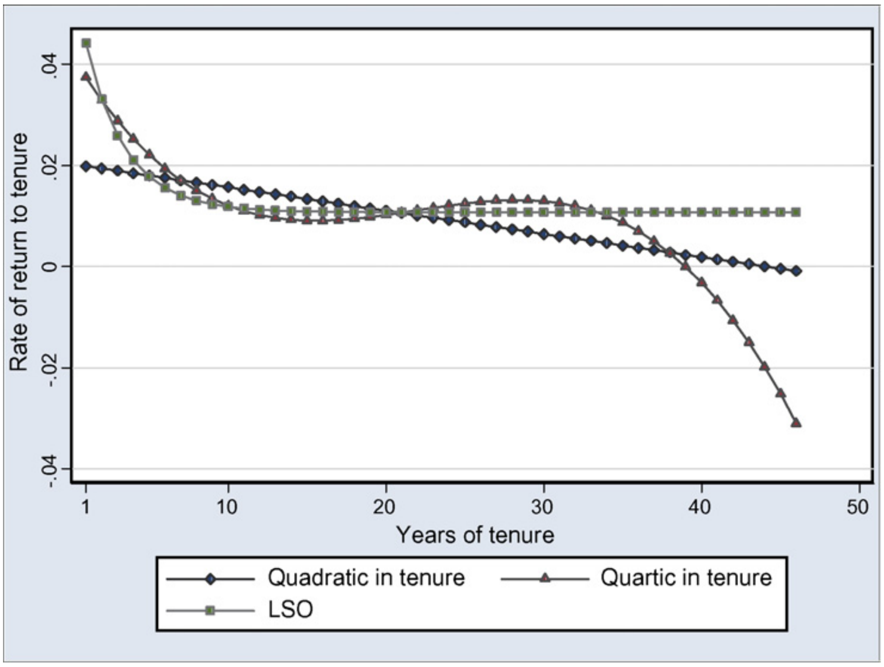

Fig. 1. Schedules of marginal rates of return to tenure for three earnings functions.

Figure 3: Destré et al., p. 935: "Schedules of marginal rates of return to tenure for three earnings functions" see also section 2.1

Formally, for worker i in firm and job j and time period t: Job-specific human capital h_{ijt}. H_{ijt} is the human capital level of the "teacher" for informal learning. Factor g is the depreciation rate of human capital (normally positive). n is the rate of knowledge diffusion in the firm.

$$h_{ijt} - h_{ij,t-1} = gh_{ij,t-1} + \frac{n}{1+n}(H_{ij,t-1} - h_{ij,t-1}), \forall t \geq 1 \tag{1}$$

Furthermore, it is shown how job-specific human capital grows with "tenure" (time on the job).

$$h_{ijt} = (1+g)^t h_{ij0}(1 + (k^t)\lambda_{ij}), \text{ with } \lambda_{ij} = \frac{H_{ij0}}{h_{ij0}} - 1 \forall \lambda ij \geq 0 \tag{3}$$

λ_{ij} denotes the job-specific learning from others' potential, it is independent of tenure. Now, the equation is converted in natural logarithms (for econometric estimation)

$$\log h_{iht} = \log h_{ij0} + gt + \log(1 + \lambda_{ij}(1 - k^t)) \tag{4}$$

λ can probably be approximated:

$$\log h_{iht} = \log h_{ij0} + gt + \lambda_{ij}(1 - k^t) \text{ with } \lambda_{ij} = \log \frac{H_{ij0}}{h_{ij0}} \tag{5}$$

Now, the logarithm of gross earnings is the sum of a linear-in-tenure experience effect and an exponential effect of learning from others that converges fast towards the firm's job-specific learning potential.

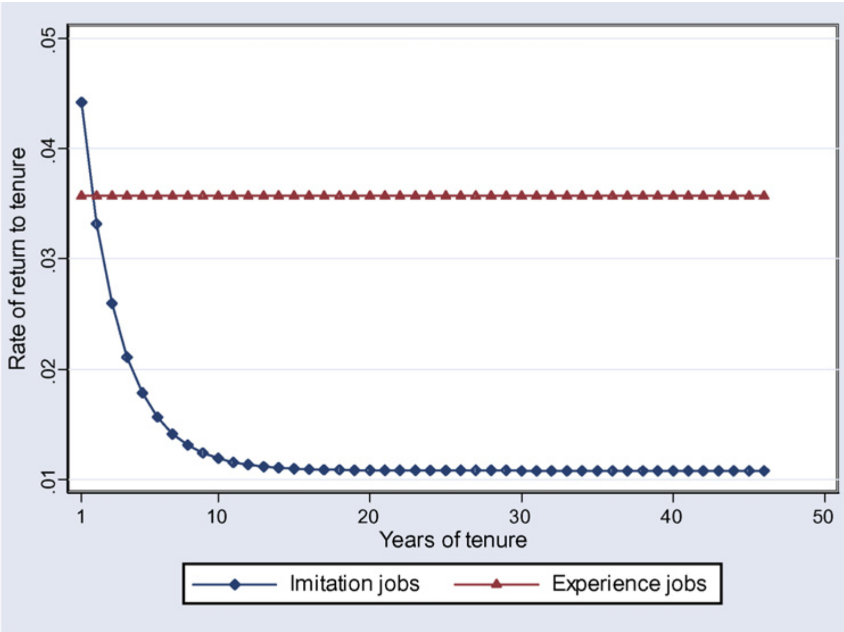

Fig. 2. Schedules of marginal rates of return to tenure for imitation and experience jobs.

Figure 4: Destré et al., p. 935: "Schedules of marginal rates of return to tenure for imitation and experience jobs" see also section 2.1

2.1.3 The returns to tenure

The marginal returns to tenure (R) are defined as:

$$R_{ijt} = \frac{h_{ijt} - h_{ij,t-1}}{h_{ij,t-1}} \; \forall t \geq 1$$

"after a few manipulations"

$$R_{ijt} = g + \frac{n}{n+1}\left(\frac{\lambda_{ij}k^{t-1}}{1+\lambda_{ij}(1-k^{t-1})}\right) \tag{6}$$

- returns to tenure is from dependent
- also depends on teacher/worker knowledge ratio
- marginal returns to tenure are shown to be a concave increasing function of the job-specific learning potential
- there is also a convex decreasing relation of the marginal return to tenure with tenure
- increasing the efficiency of learning from others on-the-job will benefit low-tenured workers who will learn faster, but it will reduce what remains to be learned from others in the future

$$\frac{\delta R_{ijt}}{\delta g} \;\geq\; 1, \text{ for } t \geq 2 \text{ and } \lambda_{ij} \geq 0 \ (= 1 \text{ if } \lambda_{ij} = 0)$$

Increasing the efficiency of experience initially increases the self-learning effect but this will provoke a multiplier effect in subsequent periods by raising the firm's knowledge.

2.1.4 Data and econometric specification

Large French cross section with matched employer-employee data, 1992 INSEE survey on labor cost and wage structure. Carried out across all EU countries. Regression analysis... additional variables defined in table 1 (p. 926).

2.1.5 Informal learning on-the-job from self and others: results

Summary of the results is given in table 2 (p. 929). Core yelling points:

- on average, it takes 1.93 years for a worker to embody 50% of what she can learn from others in her establishment, and 9.37 years to embody 95% of this in total
- in contrast to the mincerian model, the return on education is slightly lower, this is because one can "learn less" in the firm (regarding return on tenure!)
- less educated workers typically make up for lower education by more work-based learning

2.1.6 firm's knowledge and the returns to tenure

In terms of core yelling points: if there is more knowledge in the firm, the worker will have (depending on the functional form that is specified in the model) a generally higher return on tenure, since he will be able to learn more!

2.1.7 job heterogeneity

The teacher/worker knowledge ratio is quite different per firm. They then divide jobs in two categories, imitation jobs and experience jobs. Jobs that have a low potential to learn from others are called experience jobs. When you can learn from others: Imitation job. Majority of jobs are imitation jobs, only 15.8% of jobs are classified as experience jobs. Return on tenure and t/w ratio differ for these jobs! See table 6 (p. 933).

2.1.8 dualism at the establishment's level

(Establishment: Employer) ... same conclusions can be drawn ...

2.1.9 learning from jobs or learning from firms?

See figure 2 (p. 935), the rate of return to tenure is strongly decreasing for imitation jobs, whereas it stays constant for experience jobs! Furthermore, the average marginal rate of return to self-learning is considerably higher for experience jobs than for imitation jobs. Workers with experience jobs don't learn from others but by themselves. The marginal returns to education are lower in imitation jobs, more educated workers have less to learn from others.

2.1.10 conclusions

The authors have suggested a simple model of informal learning on-the-job which combines learning from (own) experience and learning from others. They find that workers on average can learn from others 10% of their own human capital on entering the firm, and catch half of their learning potential in just 2 years. Since individuals learn fast from their co-workers, the estimated returns to tenure loom larger than predicted by a quadratic, or even a quartic-in-tenure, Mincerian function in the first years and decline more sharply (until about 30 years). Learning by watching accounts for three quarters of the marginal rate of return in the first year of tenure, but this share falls rapidly, with an average of 12%. While education and self-learning on-the-job are complementary, education and learning from others on-the-job are substitutes. The more education, the less can be learned from others.

This forces the private marginal return curve to decline with education, an effect which was not captured by current theory. Seen from a different perspective, the more educated workers share the social returns of their own education with their less qualified co-workers. The potential for learning from others on the job varies across jobs and establishments, and this provides a new distinction between imitation jobs and experience jobs. Workers in imitation jobs, who learn most from others, tend to have considerably longer tenure than workers in experience jobs.

The latter are more mobile and have accumulated more market experience. Although workers in experience jobs can learn little from others, we find that they learn a lot by themselves. Consequently, we do not find a close correspondence between the imitation jobs/experience jobs "dualism" and the primary/secondary jobs and firms' dualism implied by the dual labor market theory. Even though imitation jobs imply far less turnover than experience jobs, imitation jobs do not appear to be "better" in terms of education levels and wages. We show, however, that predictions of the dual labor market theory which cannot be observed at the job's level under our classification of jobs emerge from the aggregation of jobs at the establishment level.

2.2 (Ertaut, 2000) "Non-formal learning and tacit knowledge in professional work"

2.2.1 Approach

Exploration of professional education and learning in the workplace. The aim is the clarification of the terminology associated with *non-formal learning*, *implicit learning* and *tacit knowledge*. Discussion of implications of these concepts to professional practice.

2.2.2 Definitions

NON-FORMAL LEARNING: distinguishes between *implicit learning*, *reactive on-the-spot learning* and *deliberative learning*.

TACIT KNOWLEDGE: *tacit understanding* of people and situations, *routinised actions* and the *tacit rules* that underpin intuitive decision-making. They come together when professional performance involves sequences of routinised action punctuated by rapid intuitive decisions based on tacit understanding of the situation.

Figure 1. A typology of non-formal learning

Time of Stimulus	*Implicit Learning*	*Reactive Learning*	*Deliberative Learning*
Past Episode(s)	Implicit linkage of past memories with current experience	Brief *near-spontaneous reflection* on past episodes, communications, events, experiences	*Review* of past actions, communications, events, experiences. More systematic reflection
Current Experience	A selection from experience enters the memory	*Incidental* noting of facts, opinions, impressions, ideas *Recognition of* learning opportunities	*Engagement* in decision-making, problem-solving, planned informal learning
Future Behaviour	Unconscious effects of previous experiences	Being prepared for *emergent* learning opportunities	*Planned* learning goals *Planned* learning opportunities

Figure 5: Ertaut, p. 4: "A typology of non-formal learning" see also section 2.2

TACIT PROCESSES: *reading the situation*, *making decisions*, *overt activity* and *metacognition.*
MODES OF COGNITION: *intuitive*, *analytic* and *deliberative.* The balance between these modes depends on time, experieen and complexity.Where rapid action dominates, periods of deliberation are needed to maintain critical control.

2.2.3 Findings

Types of situation in which *tacit knowledge* is acquired or used:

- Knowledge acquired by *unaware implicit learning*
- Knowledge *inferred by observers* such as implicit theories of action, schemas
- Knowledge which enables *rapid, intuitive understanding* and *response*
- Knowledge entailed in *transferring* knowledge *from one situation to another*
- Knowledge embedded in *taken-for-granted activities*, *perceptions* and *norms*

Tacit knowledge may be made specific and this is desirable in order to

- improve quality or *performance* of a person or a team
- help *communicate* knowledge to another person
- *link* aspects of performance with desirable outcomes
- construct artifacts to *assist decision-making* or reasoning

Improvement of performance is dependent on feedback. Tacit knowledge which may lie behind an action can be problematic to communicate as there is a difficulty in explaining perceptions. An observer has no access to the performer's thoughts or knowledge base. Explicitness is needed for improving performance and accountability.

Figure 2. Memory structures and knowledge-acquisition pathways in the explanatory model of tacit knowledge (modified from Horvath *et al.*, 1996)

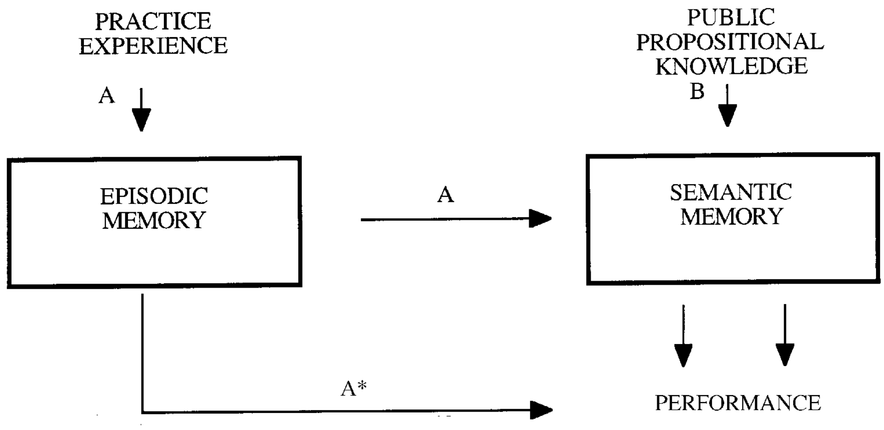

Figure 6: Ertaut, p. 5: "Memory structures and knowledge-acquisition pathways in the explanatory model of tacit knowledge" see also section 2.2

Figure 4. Interactions between time, mode of cognition and type of thought/action

Thought/Action	*Mode of Cognition*		
	Instant/Reflex	Rapid/Intuitive	Deliberative/ Analytic
Reading of the situation	Pattern recognition	Rapid interpretation	Review involving discussions and/or analysis
Decision-making	Instant response	Intuitive	Deliberative with some analysis or discussion
Overt activity	Routinised action	Routines punctuated by rapid decisions	Planned actions with periodic progress reviews
Metacognitive processes	Situational awareness	Implicit monitoring Short, reactive reflections	Conscious monitoring of thought and activity Self-management Evaluation

Figure 7: Ertaut, p. 17: "Interactions between time, mode of cognition and type of thought/action" see also section 2.2

3 Meeting 5: Selection Bias in Return on Education

3.1 (Leuven & Oosterbeek, 2008) "An alternative approach to estimate the wage returns to private-sector training"

This paper introduces the two typical kinds of upward biases found in the studies on return on education / private-sector training. These biases are the selection bias and the bias of unobservables. ($\rightarrow$ ability bias)

- There is a selection bias in many regressions of wages on training, since more able workers (= higher productivity and higher wages) self-select into training.
- It is also hard to find variables that only affect training, but not wages (this is called bias of unobservables)
- Thus, the effect of private-sector training is typically overstated
- In this paper, the authors compare the effect of private-sector training on wages of workers that took training to workers who **wanted** to take training, and to workers who wanted to take training but could not do so due to some random event. (Such as illness, etc.)
- Here, the selection bias should be much smaller, because the comparison group **self-selected** into pursuing training but could not attend.

Using the technique described above, the authors find a return on private-sector training of 9.5% (using simple OLS). However, comparing those workers who wanted to participate but did not with those who actually participated yields a smaller return: 6.3%. The comparison group of workers who wanted to attend but couldn't is too small to make any statements that are statistically significant.

3.2 (Leigh, 2008) "Estimating returns to education using different natural experimentation techniques"

The authors try to find the return on education in Australia using three natural experiments. Using a regular OLS regression, the return on one additional year of schooling is estimated to be 12%. However, taking the natural experiments into account:

1. **Month of birth**
   Here they look at individuals that are born just one month to late to begin schooling with their cohort. Because they assume that the other characteristics are comparable, they can identify the return (in terms of wages) of one more year of schooling. The estimated return on one additional year of schooling is found to be 8%, which in comparison with the OLS estimate suggests an ability bias of about 30%.

2. **Changes in compulsory schooling laws**
   Here they look at years in which the number of years of schooling was changed in the legislature. Therefore the authors again have a basis of comparison, because again most other characteristics of the observations are likely to be the same.
   The estimated return on one additional year of schooling is found to be 12%

3. **Twins**
   Here they look at wage differences between twins that have obtained different levels of education. Because the twins are genetically (nearly) identical, they share most of the other characteristics apart from schooling. The authors use this method to confirm their findings (OLS, IV birth, IV law). However, the results are somewhat ambiguous.

3.3 (Bedi & Gaston, 1999) "Using variation in schooling availability to estimate educational returns for Honduras"

The authors estimate the return on schooling in Honduras (for males) by looking at the actual availability of schools at the time when the individuals were eligible to start schooling. It is pointed out that most studies so far only concentrate on developed countries.
By adding school availability as an instrumental variable (see appendix **??**), the authors estimate the return on schooling to be higher than in a standard OLS regression (based on developed countries). Another interesting effect that is mentioned by the authors is that individuals with a low marginal return on schooling are more likely to be affected by low school availability. Thus, those individuals that are per se less likely to attend school will be thwarted away. Therefore, the low availability of schools hits "the lower end of the social spectrum" hardest.
Furthermore, the authors provide insights that show higher returns on schooling, when schools are scarce. In most studies the availability of schools is taken as granted, thereby negating the endogeneity of education.

3.4 Takeaway

- self-selection of clever people: overestimation of the effect of education → bias
- unobserved factors; ability versus cost of education
- policy implications: Honduras, worthwhile to invest in education? / Which level of education?
- when access to schools is not abundant, the return on schooling is higher.
- the return on schooling / training is typically between 5 - 10 %

4 Meeting 7: Measuring Skills

4.1 (Tomlinson, 1997) "Measuring competence and knowledge using employee surveys: evidence using the British Skills Survey of 1997"

4.1.1 Approach

Measuring learning in the UK and relate this to competence building systems. Get to grips with the learning economy and the role of knowledge in economic systems, draw conclusions about public policies. Uses the British Skills Survey (bss.dta, 1997) which contains self-assessment on a wide range of skills.

4.1.2 Findings

The demonstrated micro approach to knowledge and competence measurement using employee level data is a useful complement to macro-level analysis. Certain groups of workers are well ahead in the learning and knowledge stakes, mostly comprised of managers and professional workers. There are sectoral differences, for example manufacturing is predominated by advanced problem solving skills. Services on the other hand are associated with literacy, planning and teamwork skills. High technology sectors are the only ones showing significant gains over others.

The impact of introduction of computerised equipment was pervasive, affecting all dimensions of knowledge. Results suggest that there are still significant gains to be made from the use of computers. Even moderate use of computers appeared to lead to significant gains in all eight competences.

Also certain management and workplace practices have a significant impact on learning and competence building. Especially communications within the firm are significant, such as meetings where views can be expressed, quality circles and team based working. Job mobility within firms led to faster learning than job mobility between firms. A surprising result: The relative lack of impact of social relations with fellow workers.

Fig 1 Selected factor score averages by occupational group

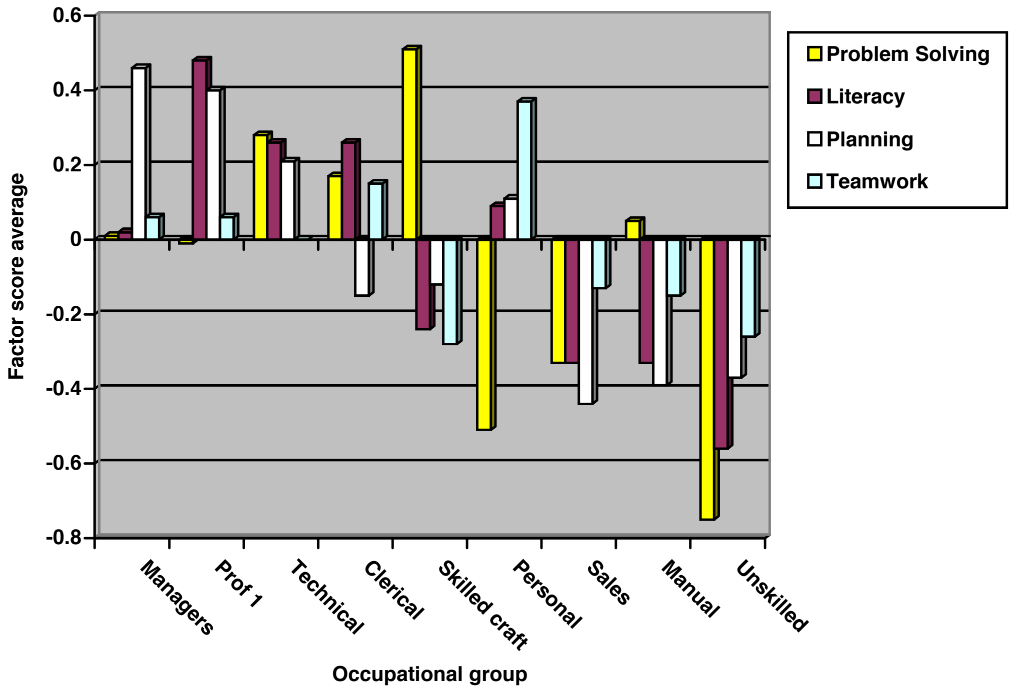

Fig 2 Selected factor score averages by sectoral groups

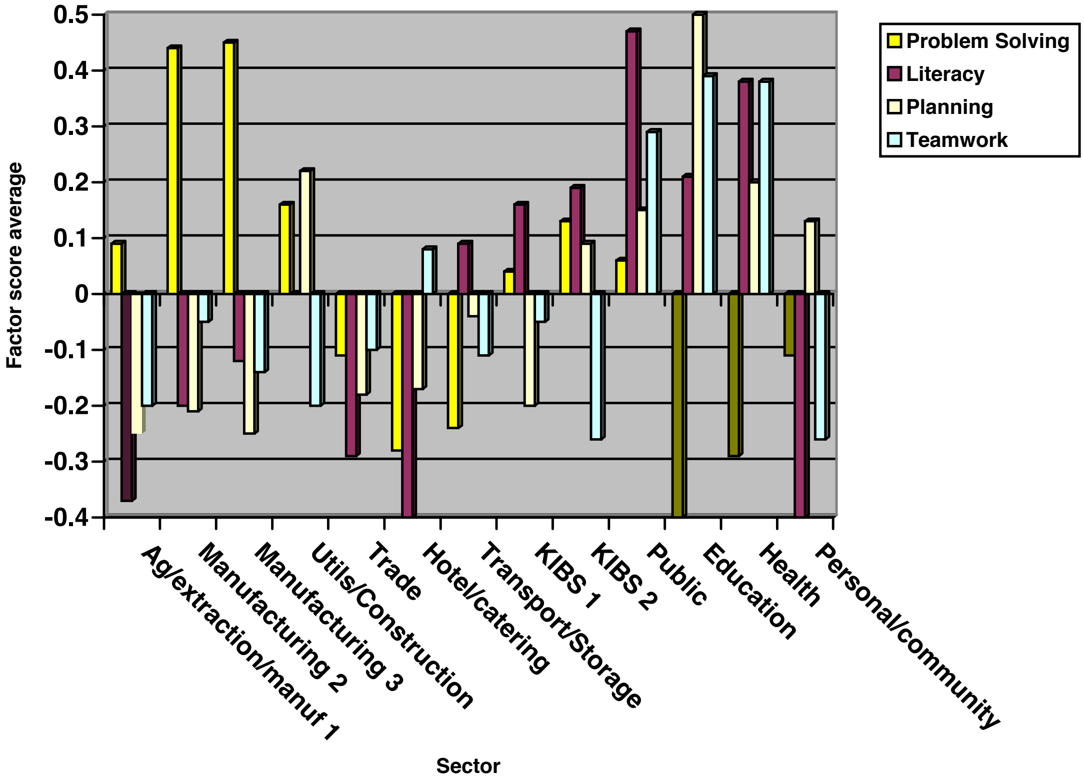

Figure 8: Tomlinson, p. 15: "Selected factor score averages by occupational and sectorial groups" see also section 4.1

5 Meeting 8: Depreciation of Skills

5.1 (De Grip & Van Loo, 2002) "The Economics of Skills Obsolescence: A Review"

The authors summarize the literature on skills obsolescence. Three main types are identified (see figure 11).

- **Technical Skills Obsolescence**
  This type captures the depreciation of human capital that takes place either through the ageing process (or illness, injury) or through atrophy (the skill is not used and this forgotten). Atrophy is an interesting factor here, because the effect is very pronounced during unemployment, when most of the skills of an individual are just not used. The chapter mentions a study about the "age-earning profile in case of work interruption". This study does not only take unemployment into consideration, but mostly women giving birth, or cases of prolonged sickness. (see figure 9)

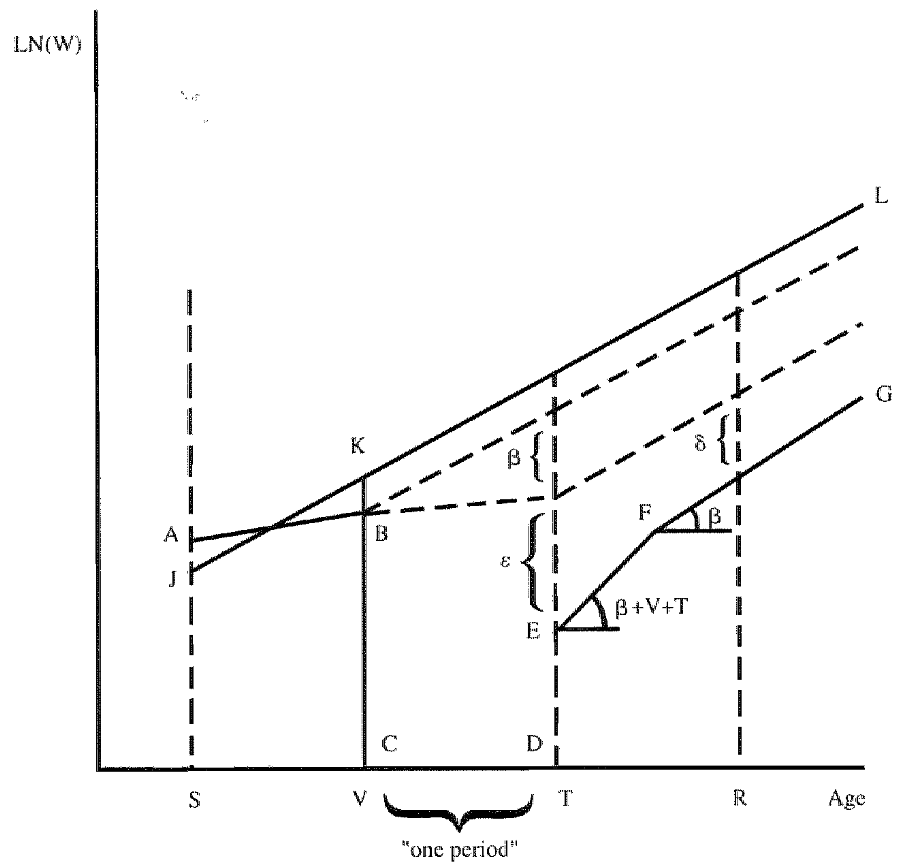

Figure 9: De Grip, p. 4: "Age-earning Profile in Case of Career Interruption" see also section ??

- **Economic Skills Obsolescence**
  However, skills can also become obsolete when new developments in society make them unnecessary (such as technical progress), or when a sector of the industry

is shifted elsewhere (as for example production is shifted to China, etc.), or if the skills are firm-specific and an employee changes jobs. These factors fall into the category of **Economic** skills obsolescence. Given the skill-biased technical change that takes place at an accelerated pace, this type can be regarded as highly relevant with respect to western economies.
The notion that knowledge that has been acquired in school becomes irrelevant at an increasing speed is also shown in figure 10. This figure shows the relationship between experience and earnings for different vintages of schooling. (Respectively for individuals that had eight, 12, and 16 years of schooling). We can see that there is a "tipping point" at which the relationship turns negative (probably due to economic skills obsolescence). The resulting "skills-upgrading" is strongest in computer intensive industries.

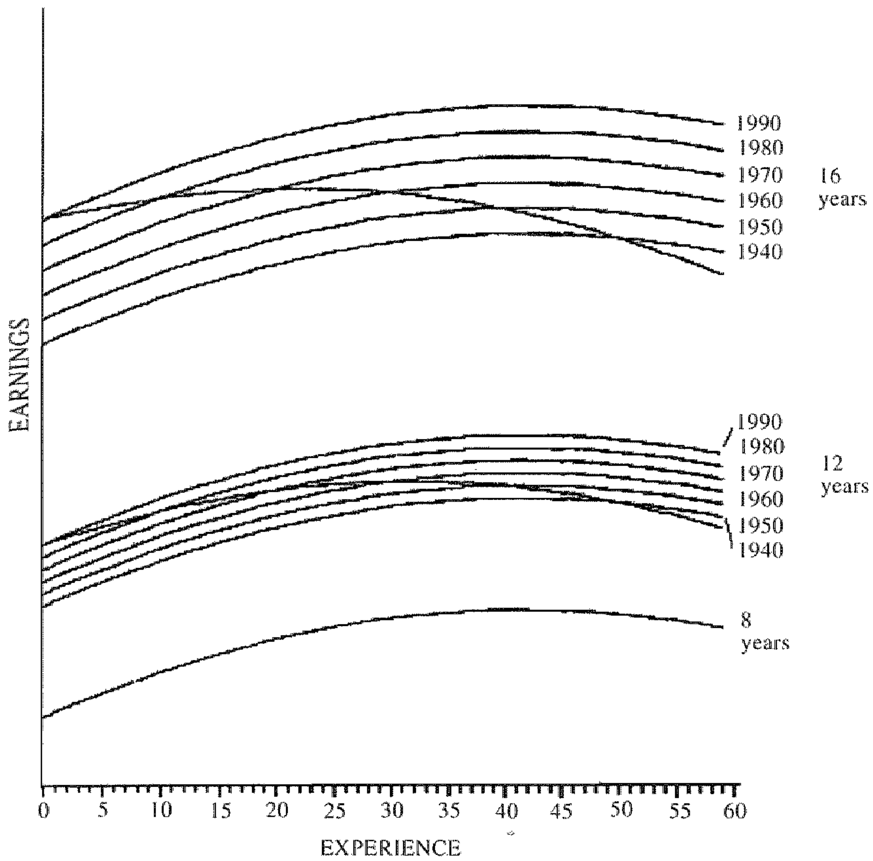

Fig. 2. The Effect of Schooling Vintage on Experience-Earnings Profiles.

Figure 10: De Grip, p. 12

- **Organizational Forgetting**
  Here, skills obsolescence in the sense that an organization forgets a set of skills or practices, for example by the aggregated wear and tear or by personnel turn-over. (e.g. a fast-foot franchise forgets faster than a ship-building company)

The authors link their findings to recent developments in the "life long learning" literature and add that the efforts to preserve human capital in the ageing western societies

Table 1. Types of Skills Obsolescence.

Type of skills obsolescence	Depreciation of human capital by:
Technical skills obsolescence	
• Wear	Natural ageing process, illness, or injury
• Atrophy	No or insufficient use of skills
Economic skills obsolescence	
• Job-specific skills obsolescence	New skill requirements due to developments in society
• Skills obsolescence by sectoral shifts	Shrinking employment in occupation or economic sector
• Firm-specific skills obsolescence	External mobility
Organizational forgetting	The aggregate of wear of skills of individual workers, or quits of workers with firm-specific skills

Figure 11: De Grip, p. 4

should take into account *which* skills become obsolete more quickly.

5.2 (Mincer & Ofek, 1982) "Interrupted Work Careers: Depreciation and Restoration of Human Capital"

This article discusses the wages before and after interruptions in work careers. (This links to figure 9). The authors show, that real wages at reentry are lower than at the point of withdrawal. This decline increases with the duration of the interruption. However, after reentry, there is a rapid growth of the real wage. The authors link this growth to the rapid restoration of human capital (that depreciated in that sense during the interruption)
It is expected the both general and specific human capital depreciate. The difference in these types of human capital with respect to depreciation is that losses in general capital accumulate over the time of interruption, while the loss of specific capital seems to be a once-for-all phenomenon.
Due to the fact that the likelihood of reentry in the labor market declines with the length of the interruption, it stands to reason to assume that the effects of skill depreciation are understated in the article.
An effect similar to those of work interruptions can be observed in migration. Workers that come to the U.S. earn a lot less money at first, but then move to higher wages quickly (on average). The authors suspect that this effect has to do with the readaptation of human capital to another labor market. One has to note though, that the migration pattern in the time-frame of the analysis displays the immigration of high-skilled workers. Thus, one might also argue, that immigrants move to higher wages more quickly because they just invested more in human capital before coming to the U.S.

5.3 (Edin & Gustavsson, 2005) "Time out of work and skill depreciation"

The authors investigate the effect of skill depreciation in the relationship between work interruptions and subsequent wages. They find strong evidence for a negative relationship between work interruptions and skills. Furthermore, the authors find that the depreciation of information processing skills is economically significant, and that a full year of non-employment is equivalent to moving 5 percentiles down the skill distribution.
This article could be especially relevant since the authors use the IALS survey data
The authors mention two main strands in the literature about skill depreciation. The first strand focusses on women that leave their job to give birth and initially raise the child, before finally reentering the labor market. The second strand focusses on the role of unemployment on skill depreciation, especially with regard to long-term unemployment. To test empirically, the authors use the Swedish part of the IALS survey from 1994-1998. The authors first check that there is indeed a positive relationship between skills and wages. Then, they check the relationship between "time out" and skill depreciation.

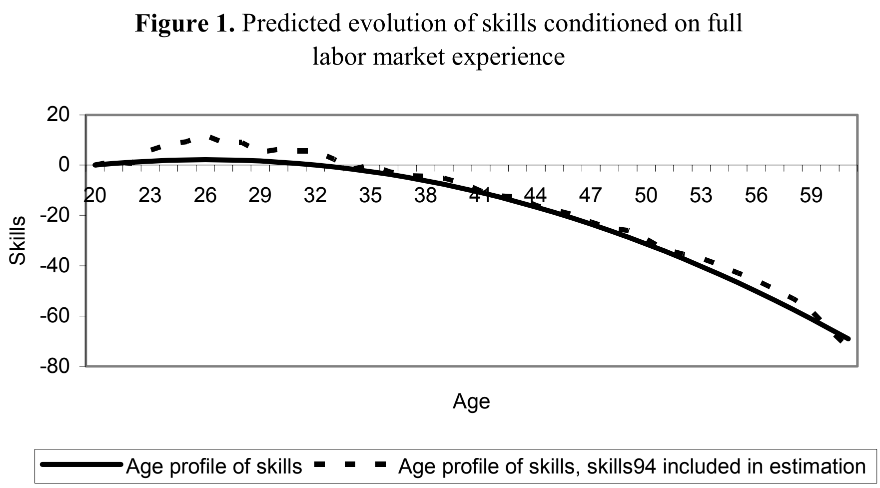

Figure 12: Edin, p. 16

As a benchmark, the authors look at the general relationship of age and skills given full employment (see figure 12). We see again that there is a maximum at a certain age (26), after that skills decrease. In comparison to interrupted work careers, the relationship does indeed differ significantly. Time out of work decreases the skill level.
Finally, the authors check if this lowered skill level is significant economically. Here they conclude that there is convincing evidence only for information processing skills.

6 Meeting 10: Encouraging Human Capital Investment

6.1 (Heckman, 2000) "Policies to foster human capital"

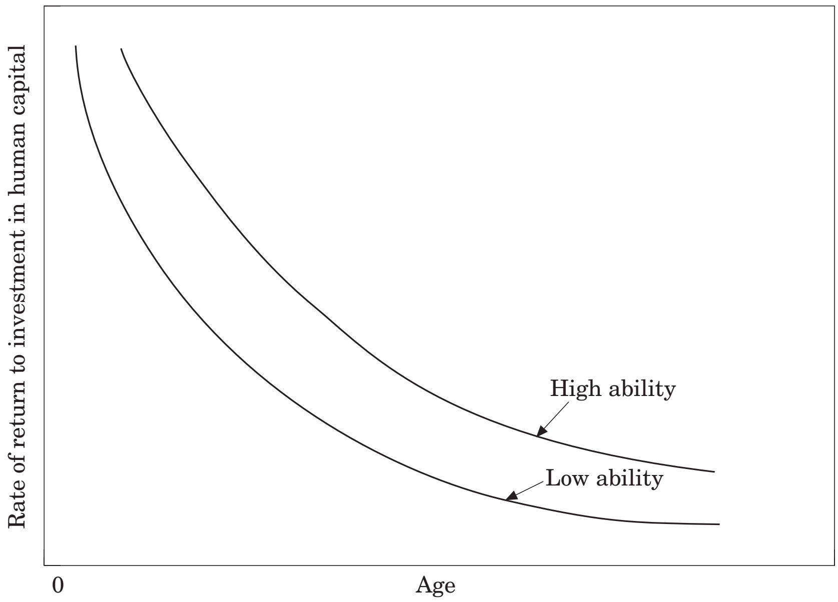

FIGURE A. Rate of return to investment in human capital.

Figure 13: Heckman, p. 7: "Rate of return to investment in human capital." see also section 6.1

6.1.1 Approach

The paper considers the sources of skill formation in current economies and the importance of cognitive and non-cognitive skills in producing economics and social success as well. Also academic institutions, families and firms are examined as sources of learning.

6.1.2 Findings

Skills beget skills. Early investments into learning pay off much more than later investments. Non-cognitive skills and motivation are important determinants of success, much more than is usually recognized. Non-cognitive skills can be improved more successfully and at later ages than basic cognitive skills. Methods currently used to evaluate educational interventions mostly ignore these non-cognitive skills and therefore understate the benefits of early intervention programmes and mentoring and teenage motivation programmes. American society under-invests in the very young and over-invests in mature adults with low skills.

Learning begets learning: Significant improvements in the skill levels are unlikely without substantial improvements in the arrangements that foster early learning. Learning is most effective when it begins at a young age. Government interventions at an early

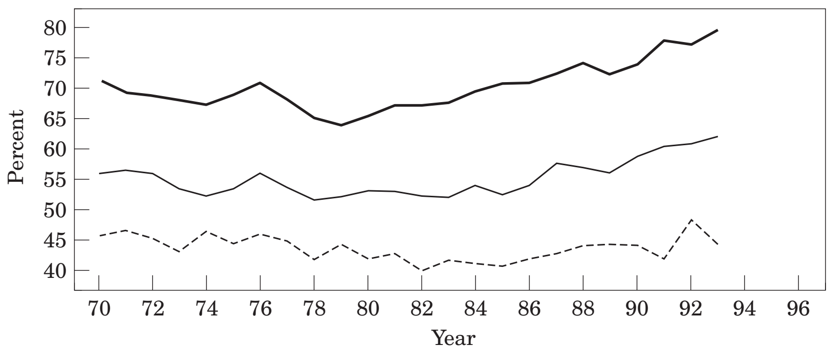

FIGURE B. College participation by 18 to 24 year-old high school graduates and equivalency degree holders. Family Income Quartile: —— Top half, —— third quartile, ---- bottom quartile.
Source: The 1971 to 1989 numbers were calculated from CPS P-20 school reports, and the 1990–1993 figures are authors' calculations from October CPS data files.
Note: High School completion includes equivalency degrees.

Figure 14: Heckman, p. 11: "College participation by 18 to 24 year-old high school graduates and equivalency degree holders" see also section 6.1

age that mend the harm done by dysfunctional families have proven to be highly effective. This early learning is more effective for two reasons:

- younger persons have a longer horizon over which to recoup the fruits of their investments
- skill begets skill

Adults past a certain age and below a certain skill level obtain poor returns to skill investment. Reallocation of funds from investment in the old and unskilled to the young and more trainable produce more favourable outcomes in the long run. Private training programmes have two advantages:

- they can train workers who are likely to benefit
- they can tailor their training programmes to market needs

By encouraging work rather than unemployment and crime, wage subsidies for the older generation in light of a technological shift may also provide social benefits that extend beyond individual increases in earnings. Governments subsidize higher education, and those subsidies benefit both unskilled and skilled workers. Evidence that borrowing constraints are important deterrents to college attendance is very weak though. Lower family income levels are associated with less productive family and neighbourhood environments, as well as lower motivation and ability by prospective students. Available evidence suggests that additional spending on public school quality would be inefficient. Reforms in the administrative structure of education and infusion of incentives and competition are far more likely to be effective.

Reforms to eliminate progressivity in the tax system will have only small effects on human capital accumulation. Far more important for wage growth and economic efficiency

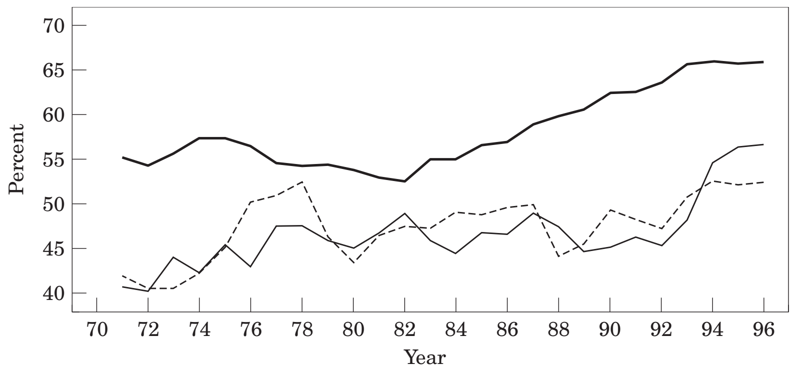

FIGURE C. College entry proportions of 21 to 24 year-olds who have graduated high school or obtained an equivalency degree. Race-ethnicity: —— White, —— Black, ---- Hispanic. These series are 3-year moving averages of the raw data. Racial-ethnic groups are defined mutually exclusively.
Source: Authors' calculations from 1971 to 1996 March CPS data files.

Figure 15: Heckman, p. 14: "College entry proportions of 21 to 24 year-olds who have graduated high school or obtained an equivalency degree" see also section 6.1

are reforms in the taxation of capital. Promoting capital formation raises the real wages of skilled and unskilled workers with only slight effects on inequality in earnings.

6.2 (Jenkins & Vignoles, 2003) "The determinants and labour market effects of lifelong learning"

6.2.1 Approach

Uses rich longitudinal panel data to find key factors that determine whether someone undertakes lifelong learning and models the effect of the different qualifications on wages and the likelihood of being employed.

6.2.2 Findings

Similar to Heckman, learning begets learning. Undertaking one episode of lifelong learning also increased the probability of undertaking more lifelong learning. Acquiring qualifications at school increases the likelihood of undertaking lifelong learning. There is little evidence of positive wage effects. Some specific types of lifelong learning do appear to boost the wages of the least qualified workers. Robust evidence that men who left school with only low-level qualifications, who then acquired degrees via lifelong learning, earned more than their peers. Stronger evidence of employment effects from lifelong learning, associated with a higher probability of being in the labour market. One possible explanation for the results is that qualifications provide a signal to employers of a person's ability to do the job. Perhaps acquiring qualifications late in life does not send the same signal to employers as acquiring them early on.

TABLE 4. *School quality discounted net returns to raising spending per pupil by 10%*

Education	*Annual rate of return to earnings of schooling quality*			
	1%	*1·5%*	*2%*	*5%*
10 years	−3422	−2987	−2552	56
12 years	−3861	−3366	−2869	106
14 years	−4315	−3800	−3285	−196
16 years	−4523	−3898	−3273	476

Source: Heckman *et al*. (1997).

Figure 16: Heckman, p. 20: ”School quality discounted net returns to raising spending per pupil by 10%” see also section 6.1

TABLE 12. *Rates of return on investments in private sector job training*

Data Set	
PSID, all males	23·5
EOPP, young new hires	8·7
NLS	16·0
NLS (Old NLS)	26·0

Source: Mincer (1993)

Figure 17: Heckman, p. 37: ”Rates of return on investments in private sector job training” see also section 6.1

A Glossary

A.1 Instrumental Variables (IV)

In statistics, econometrics, epidemiology and related disciplines, the method of instrumental variables (IV) is used to estimate causal relationships when controlled experiments are not feasible. Statistically, IV methods allow consistent estimation when the explanatory variables (covariates) are correlated with the error terms. Such correlation may occur when the dependent variable causes at least one of the covariates ("reverse" causation), when there are relevant explanatory variables which are omitted from the model, or when the covariates are subject to measurement error. In this situation, ordinary linear regression generally produces biased and inconsistent estimates. However, if an instrument is available, consistent estimates may still be obtained. An instrument is a variable that does not itself belong in the explanatory equation and is correlated with the endogenous explanatory variables, conditional on the other covariates.

In linear models, there are two main requirements for using an IV:

- The instrument must be correlated with the endogenous explanatory variables, conditional on the other covariates.
- The instrument cannot be correlated with the error term in the explanatory equation, that is, the instrument cannot suffer from the same problem as the original predicting variable.

Source: Wikipedia